CRIMSON PUBLISHERS
Wings to the Research

Open Journal of
Cardiology & Heart Diseases

ISSN 2578-0204

Mini Review

Severity of Chronic Mitral Valve Regurgitation as Determined by Magnetic Resonance Imaging: A Mini Review of Recent Clinical Studies

Per Lav Madsen*

Department of Cardiology S103, University Hospital of Copenhagen, Denmark

***Corresponding author:** Per Lav Madsen, Dept Cardiology S103, University Hospital of Copenhagen Herlev-Gentofte Hospital, Herlev Ringvej 75, 2730 Herlev, Denmark, Email: lav.madsen@gmail.com

Submission: April 02, 2018; **Published:** April 18, 2018

Introduction

Primary mitral valve regurgitation is the second most frequent valve disease in the Western world. Definite treatment is surgical with few controlled studies to rely on. In general mild and mild/moderate regurgitation is well tolerated for years, but severe regurgitation often necessitates valve surgery. It is equally important to rule out severe mitral valve regurgitation, since unnecessary surgery can be avoided, but also rule in severe regurgitation because surgery too late often may be associated with an unfavourable outcome due to poor left ventricular function going unnoticed as a result of the mitral valve regurgitation related low impedance to left ventricular output [1-4]. In general, mitral valve regurgitation severity is determined by echocardiography, either transthoracic or transesophageal. Obviously it is important to understand the anatomical cause of regurgitation (only prolapse, or also flail cusp(-s)?) since prognosis is related to the underlying mechanism, but overall the pathophysiological more important parameter to determine is the mitral valve regurgitation volume, since it is this volume, and its relation to the left ventricular total stroke volume, that determines severity and impact on left ventricle preload. With echocardiography, the mitral valve regurgitation volume may be determined with the PISA technique, but good intra- and inter observer variability is only accomplished in experienced centres. In recent years, magnetic resonance imaging (CMR) has emerged as a favourable technique for determination of mitral valve regurgitation volume. In this invited non-cost mini review, recent studies on determination of mitral valve regurgitation severity with CMR are reviewed and the preferred technique for severity determination with CMR is explained.

The preferred technique of CMR

With CMR good imaging of the four chambers of the heart and the associated great vessels of the thoracic cavity can be accomplished. With modern steady-state free precession sequences there is good contrast between blood, myocardium and valve tissue, and hence it is possible to delineate the endocardium of both the left ventricle and the left atrium with high intra- and interrater repeatability. With such imaging a stack of moving pictures ("cines") is acquired. Each film is obtained gated to the ECG, and each heartbeat as seen on the screen is comprised of 8-12 normal heartbeats combined. It is therefore of importance that the patient has a regular heart rate, since extra systoles or atrial fibrillation make imaging with CMR difficult. A normal mitral valve study includes conventional 2-, 3-, and 4-chamber views in addition to a cardiac short axis stack. If the right ventricle is considered of importance also a horizontally oriented cine stack is often acquired, since this allows for better delineation of the tricuspid valve and hence for better intra- and interrater repeatability during determination of right ventricular and right atrial volumes. In a cardiac short axis stack, the heart is imaged from above the left atrium to below the left ventricular apex usually in 7-8mm thick slices with or without interslice gaps (of 1-2mm). From the cardiac short axis stack, the left ventricular end-diastolic and end-systolic volumes are determined usually by the help of semi-automatic software with modern dedicated software of sufficient quality to determine these with analysis repeatability comparable to well-trained specialists.

From the left ventricular end-diastolic and end-systolic volumes the left ventricular stroke volume is determined. In addition to this determination, with flow-sequences, flow across the aortic valve is determined [5,6]. The mitral valve regurgitation volume is now easily determined as the difference between the left ventricular stroke volume and the forward aortic flow. If for example the left ventricular stroke volume is 120mL/beat, and the forward flow across the aortic valve is 90mL/beat, the mitral valve regurgitation volume is 30mL/beat; or 25% of the left ventricular stroke volume. In theory, but not yet much practiced, it should be possible to assess the mitral regurgitation volume by applying a flow sequence across the mitral valve [7], but with current CMR technique the anatomical position of the flow sequence is fixed, and since the mitral valve plane moves some 10mm during the cardiac cycle this technique is considered to be fraught with pit-falls. This is so also because

the mitral valve regurgitation jet(-s) is often oblique. Thus, the currently accepted technique is the "indirect technique" by which the mitral valve regurgitation volume is determined from the left ventricular stroke volume and the aortic flow.

With CMR gadolinium contrast studies, it is part of the standard set-up to determine any segments of the left ventricle with myocardial fibrosis and hence left ventricular dilatation from another cause than mitral valve regurgitation (for example recent myocardial infarction). In case of associated chest discomfort with CMR, reference standard myocardial perfusion can be assessed before and after adenosine stress. Atrial and ventricular volumes are compared with published normal values for age and gender [8] and in addition the left ventricular volume is compared to the right ventricular volume. In normal subjects, the right and left ventricular volumes are of equal size, or the right ventricular end-diastolic volume is 10-15mL larger than the left ventricular end-diastolic volume, supplying an "internal reference" for determination of left ventricular dilatation.

Clinical studies with CMR on mitral valve regurgitation

In recent years, CMR has been increasingly used to determine mitral valve regurgitation. With echocardiography mitral valve regurgitation severity has mainly been determined from an "integrated approach". Thus, usually a mitral valve regurgitation volume is determined if the mitral valve regurgitation jets allow for a meaningful PISA determination, but severity is usually determined from a number of related parameters, including left ventricular diameters (increases with severity), left atrial dimensions (increases with severity), and determination of valve pathology (a flail valve would for example be associated with severe mitral valve regurgitation). Thus, while the standard approach to accepting a new technique into the clinic would be comparison to the previous reference standard, the so far scientifically applied set-ups to determine mitral valve regurgitation with CMR and to put the results into already established context with echocardiography have taken different approaches.

In 72 patients with a spectrum of primary mitral valve regurgitation, Aplin et al. [9] determined what CMR parameters would relate to accomplished echocardiographers judgement of a particular patient as having "mild", "moderate" and "severe" mitral valve regurgitation. This study has provided a "calibration" of findings with CMR. The most important group to diagnose is the group of patients with "severe" mitral valve regurgitation since these patients may need surgery before the left ventricle fails making surgery difficult. With CMR and with integrated echocardiography as the comparator (double blinded analysis of echo and CMR studies) a patient with severe mitral valve regurgitation has mitral valve regurgitation volumes >40mL (with the average in the Aplin et al. [9] cohort being approx. 80mL) with left ventricular end-diastolic volume >108mL/m2. Total left heart volume is >188mL/m2 as left atrial volume increases >100 mL/m2 with consequent distension of individual pulmonary veins >10mm/m2. In normal subjects, the right ventricular end-diastolic volume is the same (or slightly higher) than the left ventricular end-diastolic volume, but with severe mitral valve regurgitation, the left ventricular end-diastolic volume becomes >1.2 times larger than the right ventricular end-diastolic volume.

Myerson et al. [10] followed 108 patients originally scanned with CMR for mitral valve regurgitation for up to 8 years, and found that mitral valve regurgitation volumes of >55mL and regurgitation fractions >40% were the best predictors of need for surgery within the next 2-3 years (based on conventional parameters).

Uretsky et al. [11] in 103 patients with mitral valve regurgitation compared left ventricular remodelling in patients with significant mitral valve regurgitation sent for surgery and found that remodelling after surgery was little reflected by echo parameters, but was well-reflected by CMR hence demonstrating CMRs ability to adequately determine the effect on the left heart of mitral valve regurgitation. Aplin et al. [9] demonstrated a similar correlation of pre-surgery determination of mitral valve regurgitation volume to post-surgical remodelling; ie. the higher the measured mitral valve regurgitation volume, the more the left ventricle decreased in volume post-surgery demonstrating the significant impact of the regurgitation volume on left ventricular preload.

Clinical perspectives

In conclusion, while CMR is comparably more expensive than echocardiography and scanner capacity is still limited in most centres, in patients with moderate to severe mitral valve regurgitation CMR should be considered for a full evaluation. With current technique, analysis of valve morphology (flail valve? calcification?) is best performed with echocardiography and in most patients it is easy to determine if a valve lesion is trivial or severe, but in patients with moderate to severe mitral valve regurgitation, especially so if surgery is contemplated, the impact of the valve lesion on regurgitation volume and associated chamber dilatation is best performed with the reference technique for these of CMR. Patients with a distended left heart, with left ventricular end-diastolic volumes >108mL/m2 solely based on mitral valve regurgitation and mitral valve regurgitation volume >40mL must be followed closely. Based on conventional parameters for surgery a mitral valve regurgitation volume >55mL is associated with a risk for progression to surgery within the next 2-3 years. More importantly, however, it must be kept in mind that decision for surgery is still not founded on randomized studies, and such studies should be performed with a combination of echo and CMR parameters.

References

1. Nishimura RA, Otto C (2014) 2014 ACC/AHA valve guidelines: earlier intervention for chronic mitral regurgitation. Heart 100(12): 905-907.

2. Samad Z, Kaul P, Shaw LK, Glower DD, Velazquez EJ, et al. (2011) Impact of early surgery on survival of patients with severe mitral regurgitation. Heart 97(3): 221-224.

3. Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, et al. (2014) 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 129(23): 2440-2492.

4. Vahanian A, Alfieri O, Andreotti F, Antunes MJ, Barón Esquivias G, et al. (2012) Guidelines on the management of valvular heart disease (version 2012). Eur Heart J 33(19): 2451-2496.

5. Chatzimavroudis GP, Oshinski JN, Franch RH, Walker PG, Yoganathan AP, et al. (2001) Evaluation of the precision of magnetic resonance phase velocity mapping for blood flow measurements. J Cardiovasc Magn Reson 3(1): 11-19.

6. Kramer CM, Barkhausen J, Flamm SD, Kim RJ, Nagel E, et al. (2008) Standardized cardiovascular magnetic resonance imaging (CMR) protocols, society for cardiovascular magnetic resonance: board of trustees task force on standardized protocols. J Cardiovasc Magn Reson 15: 91.

7. Myerson SG, Francis JM, Neubauer S (2010) Direct and indirect quantification of mitral regurgitation with cardiovascular magnetic resonance, and the effect of heart rate variability. MAGMA 23(4): 243-249.

8. Kawel Boehm N, Maceira A, Valsangiacomo Buechel ER, Vogel Claussen J, Turkbey EB, et al. (2015) Normal values for cardiovascular magnetic resonance in adults and children. J Cardiovasc Magn Reson 17: 29.

9. Aplin M, Kyhl K, Bjerre J, Ihlemann N, Greenwood JP, et al. (2016) Cardiac remodelling and function with primary mitral valve insufficiency studied by magnetic resonance imaging. Eur Heart J Cardiovasc Imaging 17(8): 863-870.

10. Myerson SG, d'Arcy J, Christiansen JP, Dobson LE, Mohiaddin R, et al. (2016) Determination of clinical outcome in mitral regurgitation with cardiovascular magnetic resonance quantification. Circulation 133(23): 2287-2296.

11. Uretsky S, Gillam L, Lang R, Chaudhry FA, Argulian E, et al. (2015) Discordance between echocardiography and MRI in the assessment of mitral regurgitation severity: a prospective multicenter trial. J Am Coll Cardiol 65(11): 1078-1088.